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ABSTRACT

This paper describes the computer education programs for teachers that have been implemented by the Singapore Institute for Education. After examination of computer education programs in advanced countries, it was determined that the program in Singapore should include the following features: applications-based learning across the curriculum; learning theory-based teaching and software development; and a multi-systems approach for information delivery and networking. The resulting program contains three levels of teacher training: (1) basic knowledge of the computer and networking systems, along with use of the computer as a tool for word processing, preparation of teaching materials, and assessment and administration; (2) design and development of computer assisted instruction; and (3) learning programming and authoring languages and the teaching of these languages to students so that they can develop computer programs. The specific programs developed to provide instruction on these three levels are described, and future possibilities for use of these skills are considered. (17 references) (EW)

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COMPUTER EDUCATION FOR SINGAPORE TEACHERS IN THE INFORMATION AGE

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INTRODUCTION

Phenomenal technological development in the advanced countries in the world have posed an immense challenge to the island republic of Singapore. To keep pace with the "microchip revolution", a number of high tech projects have been launched. Since the Eighties, local private enterprises have produced some computer hardware and software. The government has also set up more effective communication and information systems in Singapore and established more telecommunication links with other parts of the world via submarine cables or communication satellites.

THE BACKGROUND

Challenges

Technological development has ripple effects on people's expectations and the employment scene. Parents nowadays are expecting computer education for their children. Employers are making new demands on the new generation workers. School teachers and principals are sensing the urgent need to be computer literate so that they can better prepare the children for their studies, future work and life in a high tech society.

How is Singapore's education system and the Institute of Education responding to this urgent need and challenge? What are some of the major considerations in planning and implementing a computer education program for teachers that attempt to meet the needs and challenges of the time? What are some of the consequences?

Educational Responses

Despite earlier attempts, computer education was only introduced fairly extensively to the Singapore schools in 1980. It focused initially on teaching computer science as a subject at the pre-university level, computer appreciation courses at the secondary level and evaluation of the effectiveness of computer assisted instruction in primary school mathematics.

Most of the school computer appreciation programs have, until 1986, concentrated mainly on programming in BASIC and LOGO and they have benefitted only a section of the school population.

According to a 1986 Singapore Ministry of Education report (Seah et al, 1986), every junior college has a computer club with membership varying from 60 - 100 students. At the secondary level, some 22,000 pupils (13.6%) are involved in computer club activities and 505 teachers are in charge of the clubs.

In the last two years, facilities for computer learning have been further improved. At present, all the 13 junior colleges have two computer labs each. One of the labs is used for the learning of computer science, the other for the teachers and other pupils. 21 out of the 130 secondary schools have their own computer labs. Each lab has at least 20 computers. The other secondary schools have at least three computers each and could apply for three more. A few primary schools have set up their own labs with subsidies from the government. This means more teachers and more students will benefit from the availability and easier accessibility of computers.

To teach the computer science course at pre-university level about 100 teachers were trained at the Nanyang University (NU) in 1980 (NU merged with the Singapore University to form the National University of Singapore). This number was augmented by university graduates in computer science, both from the local as well as foreign universities. While the Curriculum Development Institute of Singapore (CDIS) conducted courses for about 1,100 teachers in charge of computer clubs in secondary schools from 1980 to the present, many of them continued as club advisers while others have relinquished their responsibilities in the computer clubs or have left the teaching service (Loh, 1988).

The Institute of Education (IE), Singapore also played its part in training some 500 teachers for the Computer Appreciation Clubs in primary schools from 1981 - 85. From 1986, IE has adopted a new teacher education programme for pre-service students. The Practicum Curriculum was introduced and computer education has become an integral part of the training programme. By 1987, all pre-service and in-service training at the Institute of Education included a computer education course in the use of computer applications software, and computer assisted instruction courseware. Computer education has also been extended to a wider range of in-service teachers. These include teachers training to be heads of departments or school principals. In 1987, a total of about 1,000 pre - service and in-service teachers were exposed to some form of computer education at the Institute of Education.

RATIONALE AND OBJECTIVES OF IE'S COMPUTER EDUCATION PROGRAM

In response to the challeges of the Information Age and the policies of the Ministry of Education and the development in schools, the Institute of Education has reconceptualized its computer education program. Accordingly, it has identified new objectives and strategies for its implementation.

Based on research and evaluation findings from the advanced countries and recent studies by the World Bank, there is decreasing interest in BASIC programming and increasing emphasis on applications software skills. From various studies conducted in the advanced countries in the past three years, courses featuring applications software seem to appeal to students more than programming courses do. (Ramsden, 1984). There are fewer dropouts particularly among the girls after some exposure to applications-learning (Lockheed & Mandinah, 1986). Computer educators also argued for the parallel cognitive consequences of learning programming and applications software. Many of them also advocated appropriate learning theory-based software development (Vogeli, 1987).

Taking into consideration the past experience of the advanced countries like the United States, Great Britain and Australia, IE's computer education program has been reconceptualized to include the following key features:

(1) applications-based learning integrated with other media across the curriculum

(2) learning theory-based teaching and software development

(3) multi-systems approach for information delivery and networking

Integrated and Applications-based Learning Across the Curriculum

The emphasis is on the use of applications software together with other media resources in learning and teaching the various subject areas. Software packages like wordprocessors, databases, spreadsheets, graphic and statistical packages are integrated with teaching methodology courses in creating teaching and learning materials. For example, using the wordprocessor to improve writing in English , or databases for storage and access of information, spreadsheets for the analysis of statistics in social studies, or a graphic package for mathematics.

Learning Theory - based Teaching

The importance of having a sound and reasonable theoretical basis for teaching and learning with the computer

cannot be over-emphasized. Psychologists and educators have developed and tested a variety of learning theories that have provided a reasonably firm scientific basis for teaching and learning. However, most of the computer-based teaching is a poor imitation of classroom practice. For example, few mathematics and English Language courseware exhibit any awareness of principles of learning beyond Thorndikean stimulus-and-response.

Awareness and concern with the choice of software with a sound learning theory-base should be the hallmark of well-informed teachers. The more interactive tutorial programmes are usually based on holistic learning principles and cognitive learning theories. This is specially true in the learning of languages. Students are required to answer questions, select choices or type information within the context of a complete discourse rather than give one-word responses to a simple phrase or sentence. In doing so, they improve in their understanding of a complete discourse and in their writing (Sinatra, 1987).

Multi-systems Approach for Information Delivery and Networking

The ability to use multi-computing systems is crucial in the Information Age. Teaching and learning with computers should not be confined to a single machine or a single system. Instead a multi-systems approach is adopted so that all trained teachers from IE will be comfortable in using different software on different machines and different databases on different delivery and networking systems.

Based upon the above rationale, every computer education course conducted by the Institute of Education will incorporate the three features mentioned regardless of student type and level of computing ability. This is to ensure the fulfilment of IE's computer education objectives.

Objectives

From the above rationale, three key objectives were derived for IE's Computer Education programme. Robert Taylor's (1980) method of organizing the three roles for the computer in education is used. These roles are tool, tutor and tutee.

Objective One: All beginning secondary and primary teachers and potential heads of departments and principals will be trained to use the computer as a **tool** for different applications functions e.g. wordprocessing.

Objective Two: Key subject teachers should have more knowledge about the computer as a complementary means of instruction (as a **tutor**) across the curriculum. Computer assisted learning programs will assume a tutoring function

for abstract and difficult concepts. Key subject teachers should be able to pass on their skills to other teachers in schools.

Objective Three: Specially trained subject teachers should be trained to use the computers to improve pupils' reasoning skills through programming, or by creating computer assisted learning programs. In doing so, the students teach the computer (**tutee**) to create useful programs and learn something as well - a programming langugage and systems analysis.

Levels of Computer Education

To achieve the above objectives, IE's computer education program has been conceived in three levels of training. These levels of training apply both to pre-service and in-service teacher education.

Level I - Basic knowledge of parts of a computer and its peripherals and their respective functions

- Basic understanding of networking systems and knowledge of what is available and suitable for use in and outside the classroom.

- Computer as a **tool** for wordprocessing, data processing, record keeping, graphic design for preparation of teaching materials, for assessment and administration.

Level 2 - Exposure to a variety of computer assisted learning (CAL) programs that make use of the computer in the **tutor** mode in selected subject areas.

- Evaluation, selection, and utilization of CAL programs for subject teaching

- Using application software to integrate or create materials for subject teaching

Level 3 - Learning computer languages, programming languages such as BASIC and LOGO, and authoring languages like SUPERPILOT to a level of competency that will enable one to create CAL programmes in the subject areas i.e., the incorporation of the use of the computer as a **tutee.**

IMPLEMENTATION AND RESULTS

With the adoption of the rationale mentioned, every

computer course conducted by the Institute of Education has, as far as it is possible, incorporated the three features. This is to ensure that teachers are not only familiar with the use of computers, and the users and producers of this technology, but they are also able to educate pupils who reflect the same awareness and understanding of the symbiotic partnership of man and computer.

To ensure that individual needs of the teachers are met, a three-level computer education program with different kinds of courses has been implemented. The first level focuses on using the computer and computer software as a tool. In a role-related term, the user is a consumer, a worker or a citizen using computers to access, retrieve, communicate and store information. The second level looks at the tutor mode. The computer is used as an instrument to acquire knowledge and skills in specific subject areas or as a tutor to supplement teaching. Selection, evaluation and utilization of the available coursewares are of great concern. The third level incorporates the tutee mode of the computer, that is programming and research in relation to computer education.

An example of the Level 1 course is the 30 hour pre-service Information Technology in Education (ITE) course for all Diploma in Education (Dip Ed) and Certificate in Education (Cert Ed) students. The student teachers are expected to acquire skills to operate and use the computer and two local area networks - the first one is the JANET network linking all the 20 IBM JX computers, the second is the bi-lingual (English and Chinese) School Home Interactive Network Exchange (SHINE) for all subjects across the curriculum. They are expected also to learn to use applications software packages to do wordprocessing, create tables, graphs and charts, and databases for information storage. They also enjoy some hands-on experience in using the computer as a tutor when they try out and evaluate courseware in different subject areas on different machines, e.g. IBM JX, IBM PC and compatibles, Apple 2E, Acorn-BBC computers. Though most of the programs are of the tutorial types, students are asked to examine how they can be integrated and used in their lessons in the subject areas of specialization.

Results from a study evaluating the computer knowledge of Dip Ed students after taking the course (1986/87) shows that all the 376 students passed the course after mastering the required skills in wordprocessing, spreadsheet, database management and LOGO graphics. In a post-course questionnaire, 75% of them agreed that wordprocessing was important to themselves, while 81% of the Dip Ed students indicated that spreadsheets and databases were useful for their own personal management. Consistently, the maths and science students indicated that computer applications were more important or useful to them than the arts and social science students (Koh & Harper, 1987). This disciplinary difference was more marked than gender difference as male students in the 1986/87 batch made up

only 18.4 % of the total population.

The Level 1 courses for potential heads of departments and principals have a different emphasis. In the Information Technology for Educational Management (ITEM) course, the participants are exposed to at least two important applications tools - a wordprocessor and a spreadsheet, and a range of computer assisted learning (CAL) packages across the curriculum. They found the more interactive CAL programs particularly interesting and useful. The potential heads of departments, in particular, are exposed to a great variety of CAL programs in their own subject areas. They learn to evaluate and select programs for classroom teaching and individual learning by pupils.

The participants of the Further Professional Diploma in Education (FPDE) and Further Professional Certificate in Education (FPCE) programs, and the Diploma in Educational Administration (DEA) programs for secondary and primary schools, are also exposed to the School Link project of the Ministry of Education. School Link is a computer network linking the microcomputers in schools to a central computer system at headquarters. It has made available seven application systems for the schools. These include pupil management system, office system, question bank system, time-tabling system, financial system, library system and inventory system. Through the various components of the course, the participants learn not only to use the computer as tool and tutor but to manage computers and computer systems for administrative purposes.

At Level 2, the first such example is the Innovating An Educational Computing Project in School course for in-service teachers. It aims at exposing the participants to a range of applications software that can be used to create instructional materials in various curricula areas and computer assisted learning programs that have been developed on a firm pedagogical basis. These include individually and commercially produced programs as well as locally created information and educational databases such as SHINE of the Singapore Press Holdings. The participants also created their own programs by using software packages (e.g. a word-processor and a spreadsheet) and/or a language (BASIC or LOGO).

As a requirement of the course, the participants shared their knowledge and skills with the teaching faculty in schools by applying the most workable diffusion of innovation principles in conducting school-based workshops for their colleagues. Of the two participating schools in 1987, one-third of the entire teaching staff (about 80 teachers) learned word-processing and more than half were exposed to a variety of computer assisted instruction packages. One school was exposed to the SHINE database. In fact, the participating school principal himself designed two math programs for SHINE. Other teachers in the school have also indicated interest to design programs that explain difficult scientific and mathematical

concepts and English and Chinese language learning with the assistance of SHINE (Chen,1987).

Level 3 computer education courses are normally embedded within the subject teaching methodology courses. For example, Mathematics, Physics, Chemistry, Biology and Geography have included using computer to program instructional units as part of their Curricular Subject Option (CSO) courses. In these instances, the computer is used as a tutee. A number of programming and authoring languages are used. These include BASIC, LOGO, PROLOG, and SUPERPILOT. The student teachers are able to do so because they have learned these programming or authoring languages in the universities before joining the Institute of Education.

CONCLUSION

From the studies and evaluation into the computer education courses, the following conclusions emerged:

Firstly, applications software are useful for student teachers and teachers to prepare their own notes and instructional materials for the pupils. Spreadsheets are particularly useful for accumulating and analysing marks and for item analysis. The School Link database is very useful for the teachers and principals to organize, store, retrieve and communicate pupil data. Course participants are satisfied with the learning of the applications software. They have no difficulty in mastering the basic skills.

Secondly, computer assisted learning packages that aim at higher order learning are more interesting and useful than the recall and drill and practice types. Though the latter type should be used for reinforcement or for remedial purposes, often they are introduced to the schools as the only available courseware. As such the computer is used in a very limited way. And many of the uninitiated users are not convinced that computer assisted learning courseware could be integrated into their lessons. However, course participants of the ITEM course find the CAL packages used on the IBM, APPLE Macintosh and ACORN-BBC Masters Series computers and the local database - SHINE, offer some alternative types of computer assisted instruction programs in maths, science, English and Chinese languages.

Thirdly, authoring and programming languages have been used to create CAL programs that are integrated with the Cambridge Certificate of Examinations ('A' and 'O' Level) syllabi and schools' schemes of work. They could be used to create CAL programs of the more interactive types as more authoring languages that can be used for creating CAL programs have come into the market. Their full potentials have yet to be explored.

FUTURE DIRECTIONS

In view of the high tech contexts of Singapore and her trading partners, schools and teachers will not only be demonstrating their reliance upon computers and computer systems to improve the quality of administration and instruction, they will also have to prove their efficiency in employing high tech resources and the growing number of information databases. There is also expectation for the "computer experts" in schools to become the nurturers of computer talents and producers of pedagogically sound prototypic learning and teaching materials that can be shared among students of different learning ability.

The Institute of Education, being the one and only teacher education institution in Singapore, has to play an increasing leadership role in developing training programmes that will prepare teachers and school administrators for the high technology generations ahead. The computer education plan described is only the beginning of a more comprehensive teacher education program in the use of computers. There is provision for further development and expansion in line with the technological and social developments in Singapore in the future.

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